

**WHAT IS CLAIMED IS :**

1. A multi-electrode system for decontaminating a gas containing contaminants flowing therein, comprising :

a passageway for allowing said gas to flow from a first end to a second end of said passageway;

at least one set of three electrodes having two outer electrodes electrically connected together forming a first terminal and one inner electrode placed between the two outer electrodes and forming a second terminal, wherein each set is placed within said passageway and in one of a perpendicular and a parallel orientation to said flow of gas and wherein said set is permeable to said gas flow when placed in a perpendicular orientation to the gas flow;

a high voltage waveform source for supplying said first and second terminals and creating electrical fields between the outer electrodes and the inner electrode, wherein said electrical fields interact with the gas to create an electronic current having a desired average energy level to at least match the energy level of the molecular bonds of the contaminants to be at least one of ruptured, damaged and modified; and

wherein said set has at least one of

(a) at least one surface of said inner electrode and a corresponding exposed surface of said outer electrodes are fitted with protuberances having a controlled geometry on said surface thereby controlling amplification factor of said electric field at extremities of said protuberances; and

(b) a space between at least one outer electrode and said inner electrode is at least partially filled with elements made from a dielectric material.

2. A multi-electrode system as claimed in claim 1, wherein said element made from a dielectric material is at least one of granular particles and fibers.

3. A multi-electrode system as claimed in any one of claims 1 to 2, wherein said inner electrode has openings and ion traps are created within said openings due to the opposite electrical field direction on each side of said inner electrode.

4. A multi-electrode system as claimed in any one of claims 1 to 3, wherein said energy level is greater than the energy level of the molecular bonds of the contaminants.
5. A multi-electrode system as claimed in any one of claims 1 to 4, wherein an effective electric field at a tip of said protuberances is in the range of  $10^6$ V/m to  $30*10^6$ V/m.
6. A multi-electrode system as claimed in any one of claims 1 to 5, wherein said protuberances are at least one of spikes, peaks and bumps.
7. A multi-electrode system as claimed in any one of claims 1 to 6, wherein said contaminants are at least one of airborne pathogenic agents, microorganisms and undesirable chemical substances.
8. A multi-electrode system as claimed in any one of claims 1 to 7, wherein each of said sets further comprises at least one added set of two electrodes, one inner and one outer and wherein all the inner electrodes are electrically connected together and all the outer electrodes are electrically connected together thereby forming together a capacitance set with two terminals having  $1+N$  inner electrodes and  $2+N$  outer electrodes where  $N$  is the number of added sets of two electrodes, and wherein  $N$  is an integer value greater than or equal to zero.
9. A multi-electrode system as claimed in claim 8,  
wherein said capacitance set resonates at an RF frequency with an impedance network in series to provide an RF electrical field between the electrodes superposed over the electric field provided by the high voltage waveform source;  
wherein at least one terminal is connected in series with an impedance network;  
wherein said impedance network has a first inductor and a first resistor in series connected to said terminal to provide a resonant electrode function;  
wherein said impedance network has a second inductor and second resistor in series providing a current limiting function and connected in series with said first resistor and first inductor;  
whereby each electrode set is forming a capacitive load impedance and wherein that load impedance is being resonated at radio frequency with the first inductor in series with the

first resistor to increase the alternative current and improve the energy transfer between the high voltage waveform source and the electrode set.

10. A multi-electrode system as claimed in claim 8, wherein a plurality of said sets are provided and wherein each set of electrodes constitutes a decontamination stage and wherein said electrode sets are placed in succession in the gas flow and wherein each said stage has a specific electronic current density and average energy through its connection to a high voltage waveform source and creates between the electrodes a specific and controlled electrical field giving emitted electrons a controlled average specific energy susceptible to at least one of break-up and ionization the specific chemical bonds in the contaminants which have an energy matching the specific average electron energy.

11. A multi-electrode system as claimed in claim 10, wherein each specific high voltage waveform ( $V_1$ ) from said high voltage waveform source is automatically adjusted to the ratio function of the measured air density ( $D_1$ ) to the reference air density ( $D_0$ ) corresponding to the reference voltage waveform  $V_0$ , by using the gas absolute temperature and pressure measurements to determine the gas density and using the formula:  $V_1 = V_0 * (D_1/D_0)^k$  where  $k$  is selected in the range of 0.5 to 1.5.

12. A multi-electrode system as claimed in any one of claims 1 to 11 wherein the two outer electrodes are formed integrally and create a decontamination stage formed with two electrodes.

13. A multi-electrode system as claimed in any one of claims 1 to 12 wherein the sets of electrodes have a planar or cylindrical geometry.

14. A multi-electrode system as claimed in claim 2, wherein said particle is one of spherical, semi-spherical, ovoid and polygonal particle and wherein a diameter of said elements is between 1/10 to 1/500 of said space.

15. A multi-electrode system as claimed in any one of claims 1 to 14, further comprising a controller which controls parameters of the electric field created by the high voltage waveform source.
16. A multi-electrode system as claimed in claim 15, further comprising sensors for operating conditions of said system and wherein said controller adjusts said parameters to control said high voltage waveform source.
17. A multi-electrode system as claimed in claim 16, wherein said sensors are at least one of a pressure sensor, a temperature sensor, a current sensor, a voltage sensor and a light sensor.
18. A multi-electrode system as claimed in claim 16, wherein said controller has a status detector for detecting an operation status of said system and issuing a warning if at least one of abnormal and malfunction status is detected.
19. A multi-electrode system as claimed in any one of claims 1 to 18, further comprising an additional set of three conductive electrodes having two outer electrodes electrically connected together forming a first terminal and one inner electrode placed between the two outer electrodes and forming a second terminal, wherein said set is placed within said passageway after said at least one set, in one of perpendicular and parallel orientation to said flow of gas and wherein said set is permeable to said gas flow when placed in a perpendicular orientation to the gas flow, said electrodes being conductive and free of any peak and being arranged such that the electrical field generated between the electrodes is not constant over the spacing distance and has a gradient; said high voltage waveform source supplying said first and second terminals and creating an electrical fields between the outer electrodes and the inner electrode; whereby said additional set captures remaining contaminants and contaminants by-products present in the gas.
20. A multi-electrode system as claimed in any one of claims 1 to 19, further comprising:

a neutralizer stage composed of a series of one or staggered wires and fine wire meshes, isolated from each other, electrically grounded to earth at one end, placed within said passageway after said at least one set;

wherein said wires and said meshes are coated with a catalytic material;

wherein said wires and said meshes are connected to one of a voltage and a current source to heat and raise the temperature of the catalytic material;

wherein remaining charged particles and undesired by-products in said gas are neutralized.

21. A multi-electrode system for decontaminating a gas containing contaminants flowing therein, comprising :

a passageway for allowing said gas to flow from a first end to a second end of said passageway;

at least one set of two electrodes each having a terminal, wherein each set is placed within said passageway and in one of a perpendicular and a parallel orientation to said flow of gas and wherein said set is permeable to said gas flow when placed in a perpendicular orientation to the gas flow;

a high voltage waveform source for supplying said terminals and creating an electrical field between the electrodes, wherein said electrical field interacts with the gas to create an electronic current having a desired average energy level to at least match the energy level of the molecular bonds of the contaminants to be at least one of ruptured, damaged and modified; and

wherein said set has at least one of

(a) an exposed surface of said electrodes is fitted with protuberances having a controlled geometry on said surface thereby controlling an amplification factor of said electric field at extremities of said protuberances; and

(b) a space between said electrodes is at least partially filled with elements made from a dielectric material.